Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of	:	
	:	
Tariff Filing Requirements for Interstate Common Carriers	:	CC Docket No. 92-13

COMMENTS OF TELOCATOR

Telocator, the Personal Communications Industry Association, by its attorneys, respectfully submits its comments regarding the above-captioned Notice of Proposed Rulemaking.[1] For the reasons discussed herein, Telocator urges the Commission to recognize that there is no sound basis for requiring radio common carriers to file tariffs.

I. INTRODUCTION

Telocator is the national trade association for the personal communications services industry. Its members include common carrier and private paging companies, cellular telephone companies, and providers of other radio-based communications services. Telocator is filing these comments out of concern that the Commission might, for the first time, require radio common carriers ("RCCs") to file federal tariffs.

This proceeding arose out of a dispute between the two largest carriers in the long distance telephone market.[2] Specifically, in August 1989, AT&T filed a complaint

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1 FCC 92-35 (released January 28, 1992).

2 Id. at ¶¶ 1, 2.

alleging that MCI was unlawfully providing service to certain customers at off-tariff rates. MCI responded that its actions were consistent with the Commission's forbearance policies, which permit non-dominant interexchange carriers to offer service without filing a tariff.

In late January, the Commission denied AT&T's complaint, finding that reconsideration of the forbearance policy, "which represents one of the cornerstones of the Commission's regulatory framework for the long-distance industry, should not occur in the context of an adjudication between two parties."[3] Nonetheless, stating that the issues raised in AT&T's complaint are "serious and important," the Commission initiated this proceeding "to review the lawfulness and future application of our forbearance rules and policies."[4]

Not surprisingly, in light of this background, the Notice focuses on the market for long distance telephone service. An unforeseen side effect of this proceeding, however, is the threat of extending tariffing requirements to the full range of common carriers, including -- for the first time -- RCCs.

As Telocator discusses herein, there is no legal or policy basis to impose such public utility regulation on

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[3] Id. at ¶ 2.

[4] Id.

RCCs. RCCs occupy a unique jurisdictional niche that reserves to the states regulatory authority over most of their offerings. Moreover, the Commission's 1986 decision to forbear from regulating RCCs' interstate services was not only sound public policy, but was at least implicitly authorized by Congress three years before. Finally, extending tariff regulation to this intensely competitive industry would be antithetical to the public interest.

II. THERE IS NO LEGAL OR POLICY BASIS FOR IMPOSING TARIFF REGULATION ON RADIO COMMON CARRIERS.

A. RCCs Have Never Been Subject to Federal Tariff Regulation, And There Is No Legal Need to Impose a Tariff Requirement.

The Commission has never required RCCs to file tariffs. Indeed, the FCC and the courts have long recognized that traditional RCC services have unique characteristics that place most such services under state jurisdiction. Specifically, pursuant to Section 221(b) of the Communications Act, RCC services are predominantly exchange services, notwithstanding the fact that the radio signals may cross state boundaries.

For example, in Radio Telephone Communications, Inc. v. South Eastern Telephone Co.,[5] the Florida Supreme Court explained that RCC services:

> are essentially intrastate in nature, even though the radio portion of such services migh "spill over" into

[5] 170 So.2d 577 (Fla. 1965).

> the adjoining state, since a radio signal cannot recognize nor stop at a state line; and it is clear that Congress intended to reserve to the several states the right to regulate such intratate services in the manner specified in Section 221(b).

Similarly, the Commission has, "in accordance with Sections 2(b) and 221(b) of the Act, reserve[d] to the states jurisdiction with respect to charges ... for service by" cellular carriers.[6] The Notice does not address this jurisdictional issue, and certainly does not suggest that there is any reason to depart from this longstanding interpretation of Section 221(b).

Moreover, the Commission has expressly forborne from regulating those RCC services that are jurisdictionally interstate:

> we conclude that Public Land Mobile Service licensees providing interstate mobile services possess insufficient market power to charge unlawful rates ... and therefor constitute "non-dominant carriers .... [N]on-dominant carriers are subject to "forbearance," and need not file tariffs with the FCC for their interstate services.[7]

It is important to note that the Congress had explicitly recognized the possibility that the Commission would forbear

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6 Cellular Reconsideration Order, 89 F.C.C.2d 58 (1982), at ¶ 84.

7 Preemption of State Entry Regulation in the Public Land Mobile Service, 59 Rad. Reg. 2d 1518 (1986), at ¶ 33, rev'd on other grounds, NARUC v. FCC, No. 86-1205 (D.C. Cir. March 30, 1987). Subsequent to the NARUC ruling, the Commission expressly re-affirmed the validity of its decision to forbear from regulating RCCs. Preemption of State Entry in the Public Land Mobile Service, CC Docket No. 85-89, FCC 87-319 (Oct. 21, 1987).

from regulating RCCs three years before it did so. The legislative history of Section 331(c) of the Act, which preempts state regulation of private carriers, emphasizes that "[n]othing in this subsection shall be construed as prohibiting the Commission from forbearing from regulating common carrier land mobile services ...."[8] This implicit acknowledgment of the Commission's forbearance authority strongly suggests that the agency is not legally compelled to retreat from this policy now, at least with respect to RCC services.

B. The RCC Marketplace Is Exceptionally Competitive.

As the Commission acknowledged in 1986, RCCs operate in a robustly competitive marketplace. Indeed, competition in the provision of RCC services has only intensified over the past six years. Telocator is attaching to these comments excerpts from a recent study by the RBOCs, entitled "Report of the Bell Companies on Competition in Wireless Telecommunications Services, 1991", and from a Telocator report, entitled "An Overview of the Radiopaging Industry," that compellingly detail the competitive nature of the marketplace:

- The marketplace is highly unconcentrated. The largest RCC has only a 12 percent market share, and the top 10 RCCs together have a market share of only 50 percent.

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[8] House Conf. Rept. No. 97-765, 97th Cong., 2d Sess., at 56 (1982), reprinted in 1982 U.S. Code. Cong. and Ad. News 2237, 2300.

- There are a multitude of competitors. There are almost 2000 companies providing RCC services in the United States. Some metropolitan areas have as many as 50 carriers. Most RCCs offer some form of wide area or regional service, and approximately seven provide some form of nationwide service.

- The market is growing rapidly. There were 9.9 million paging subscribers at the end of 1990, which represented a 22 percent increase over 1989.

  - Over the last several years, the average annual growth rate has been 15 percent.

  - Paging industry revenues have tripled since 1984.

Moreover, RCCs face intense competition from private carrier paging companies (PCPs), which enjoy several significant advantages over RCCs. As an initial matter, they are not subject to state regulation. While, as discussed above, most states do not regulate RCCs, this immunity is a considerable benefit in those states that do. In addition, because of their private carrier status, PCPs are not now subject to any federal tariffing obligations. Nor would such requirements be extended to them as a result of this proceeding.

Given the intense competition in the RCC marketplace, tariff regulation is both unwarranted and contrary to the interests of consumers. A tariffing requirement would exacerbate the already considerable incongruities between RCCs and PCPs, impede the ability of RCCs to respond promptly and innovatively to subscribers' needs, restrain

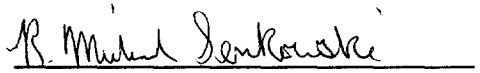
pricing flexibility, and potentially diminish price competition. Consequently, Telocator respectfully submits that imposing a tariffing requirement on RCCs would be directly contrary to the public interest.

III. CONCLUSION

For the foregoing reasons, Telocator urges the Commission not to require RCCs to file tariffs.

Respectfully submitted,

TELOCATOR

By: 

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March 30, 1992

CERTIFICATE OF SERVICE

I hereby certify that on this 30th day of March, 1992, I caused copies of the foregoing "Comments of Telocator" to be hand-delivered to the following:

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ATTACHMENT A

REPORT OF THE BELL COMPANIES ON COMPETITION IN WIRELESS TELECOMMUNICATIONS SERVICES, 1991

October 31, 1991

Since those early days, mobile telephony has developed into a multi-billion dollar industry that is helping to shape the way people work, where they live, and how they spend their leisure time. Mobile telephony bids fair to exert as great an influence on modern life as the wireline telephone itself did. Despite the recent schism between FCC regulatory policies and the consent decree, competition in the provision of mobile services has flourished. The markets have been characterized by burgeoning demand, rapid reductions in price, and steady improvement in service quality and coverage.

Paging

In the past decade, the FCC has steadily increased the amount of spectrum allocated to paging services. **TABLE 1.1.** The number of pagers in use nationwide grew from about 1 million in the late 1970s, to 2.2 million in 1983, to about 10 million in 1991; a projected 12 million pagers will be in use by 1994.[10] **FIGURE 1.1.** Revenues have grown apace, almost tripling in the years since the Bell System divestiture. **FIGURE 1.2.** Telocator Network of America, a mobile communications industry trade association, notes that "growth [in the paging industry] remains robust -- in excess of one million pagers per year."[11] Telocator expects that "the current growth trends will continue."[12] The current growth rate for paging as a whole (local, wide-area, and national) is about 15 percent per year.[13]

The fastest growth of all has come from wide-area paging services, which provide regional coverage; these services have accounted for about one-third of all growth in the industry since 1985, with annual growth rates ranging from 20 to 30 percent. **TABLE 1.2.** In 1989, one observer noted that established regional operators were vying with new nationwide providers to provide intercity paging service; the competition was described as "intense."[14]

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[10] *U.S. Paging Market Forecast to Grow by One-Third in Four Years,* FIN. TIMES LTD., Apr. 11, 1991. More optimistic projections estimate 20 million pagers will be in used by 1993. Borowsky, *Memphis on Short List for 300 -- Job Relocation,* MEMPHIS BUS. J., Jan. 28, 1991, at 1. Typical subscription fees are about $20 to $25 a month for local service; $35 a month for regional service; and about $65 a month for national coverage. Abrahms, *Mid-Atlantic Paging Stretches Network From Virginia to Boston,* WASHINGTON BUS. J., Sept. 17, 1990, § 1, at 23; Richards, *Pager Companies Count on Masses to Answer Call of Cheaper Fees,* USA TODAY, Sept. 5, 1990, at 6B; Wood, *There's No Escaping Beepers,* CHICAGO TRIBUNE, Mar. 18, 1990, at 20; EMCI, THE STATE OF THE U.S. PAGING INDUSTRY -- SUBSCRIBER GROWTH, END-USER AND CARRIER TRENDS: 1990, at 32-33 (1990); *Paging Industry Breaks 10 Million Subscriber Mark,* PR NEWSWIRE, May 12, 1991.

[11] Roscoe & Wysor, *Survey Shows Strong Growth in Paging Industry,* TELOCATOR, June 1990, at 14.

[12] *Ibid.*

[13] Feldman, *Beeper Company Sends Stronger Signal,* CRAIN'S N.Y. BUS., Aug. 6, 1990, at 3.

[14] Bean, *Paging Outlook 1995,* TELOCATOR, Jan. 1989, at 29.

Table 1.1. Radio Paging Channel Capacity.						
Type of Service	1981			1988		
	Channels Available	Subscribers Per Channel	Total Capacity (units)	Channels Available	Subscribers Per Channel	Total Capacity (units)
Tone	27	100,000	2,700,000	120	100,000	12,000,000
Tone and Voice	27	1,500	40,500	120	1,500	180,000
Tone and Alphanumeric Display	27	NA	NA	120	50,000	6,000,000
Source: Bean, *Paging Outlook 1995*, TELOCATOR, Jan. 1989, at 23.						

Paging services are provided by many different companies. By late 1990, an estimated 1,000 U.S. pager services were in operation.[15] As one pair of commentators noted, the paging industry is marked by "hundreds of small operators with less than 1,000 pagers in service and hundreds more mid-sized operators with a few thousand pagers in service."[16] But the industry has also "attracted some large, well-financed participants from outside the field, who have entered via major acquisitions. These entrants have come from the broadcast and cable television fields (Metromedia and Cox Communications), * * * the long distance business, and the venture capital sector (Golda Thoma of Chicago * * *)."[17] Only one company serves more than 10 percent of paging subscribers, and nearly half are served by companies with market shares too small to tabulate. Telocator predicts that growth will remain "healthy for [both] large nationwide carriers and small localized operations."[18]

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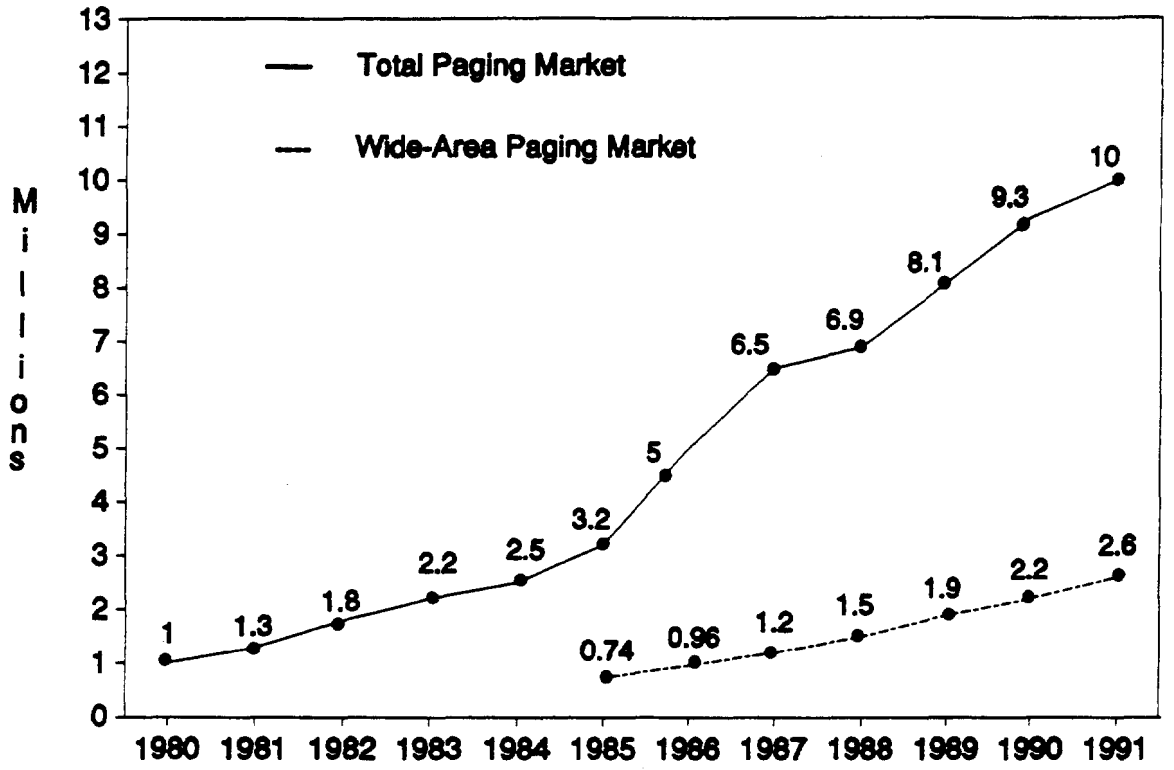
[15]Richards, ***Pager Companies Count on Masses to Answer Call of Cheaper Fees***, USA TODAY, Sept. 5, 1990, at 6B.

[16]Roscoe & Wysor, *Survey Shows Strong Growth in Paging Industry*, TELOCATOR, June 1990, at 15.

[17]Bean, *Paging Outlook 1995*, TELOCATOR, Jan. 1989, at 28. There has been some consolidation in the industry; as one observer noted in 1989, "[t]he industry has evolved from small independent 'mom and pop' companies (hundreds still exist profitably) to large megacompanies serving hundreds of thousands of users." Kirvan, *Radio Paging Still Hot: An Old Familiar Way to Keep in Touch Has Gotten Even Better*, ELECTRONIC MESSAGING, Aug. 1989, at 34.

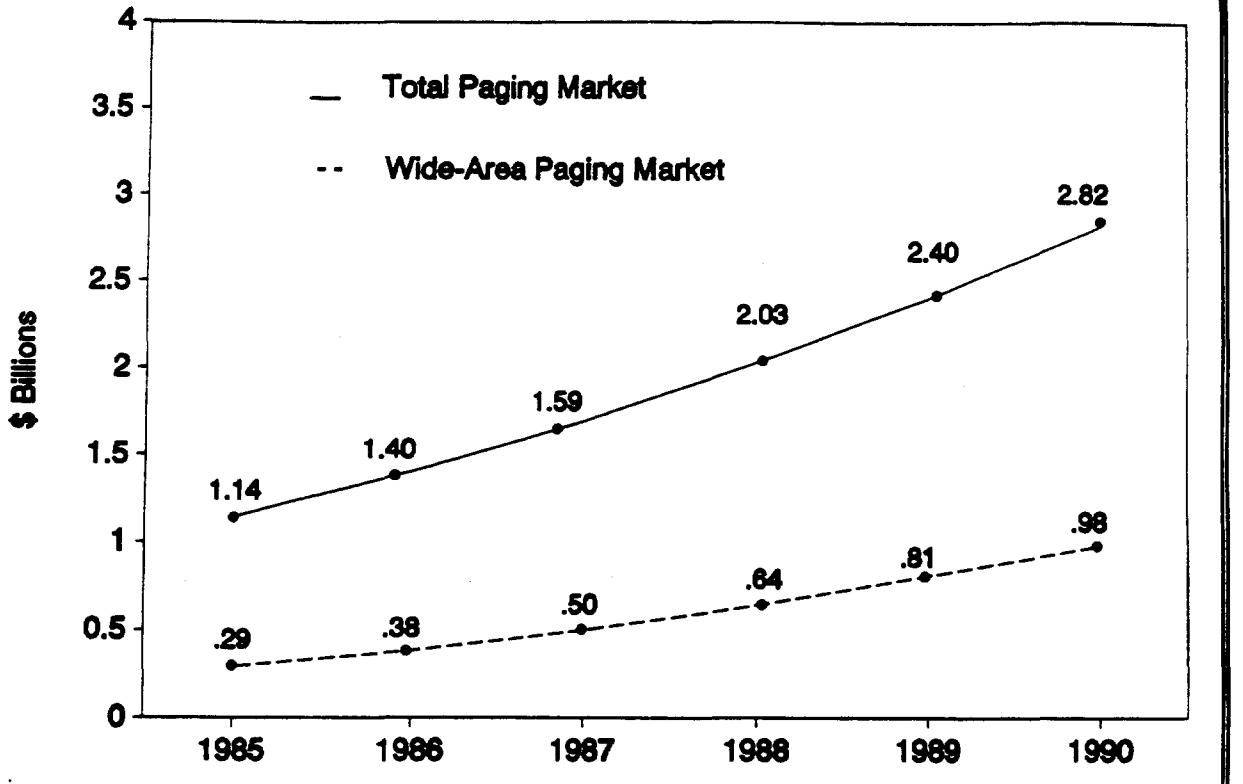
[18]Roscoe & Wysor, *Survey Shows Strong Growth in Paging Industry*, TELOCATOR, June 1990, at 14.

Figure 1.1. Growth of Paging Subscribers.[19]



[19]Sources: EMCI, THE STATE OF THE U.S. PAGING INDUSTRY – SUBSCRIBER GROWTH, END-USER, AND CARRIER TRENDS: 1990, at 32-33 (1990) (total paging market figures); Roscoe & Wysor, *Survey Shows Strong Growth in Paging Industry*, TELOCATOR, June 1990, at 14 (same); Bean, *Paging Outlook 1995*, TELOCATOR, Jan. 1989, at 20 (same); MIRC, MOBILE COMMUNICATIONS SERVICES, at VI-21 (1990) (wide-area paging market data; subscriber figures were not available for pre-1985). The wide-area paging market makes up from 16% (in 1985) to 24% (projected 1990) of the total number of subscribers in the one-way paging market. *See id.* at VI-9; *Paging Industry Breaks 10 Million Subscriber Mark*, PR NEWSWIRE, May 12, 1991 (1991 total paging market figure).

Figure 1.2. Growth of Paging Revenues.[20]



New companies continue to enter and succeed in the market. SkyTel's Skypager service, for example, was first offered in 1987; by late 1990 it had 84,300 users in the United States[21] and continues to add 4,000 to 5,000 subscribers a month.[22] Today, Skypager is the largest nationwide service, and was the first nationwide network currently operating on a single frequency.[23] SkyTel has also been in the forefront of efforts to

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[20]Source: MIRC, MOBILE COMMUNICATIONS SERVICES, at VI-2, VI-21 (1990) (data for 1989 and 1990 are estimates). The wide-area paging market makes up from 25% (in 1985) to 35% (projected 1990) of total one-way paging revenues. *See id.* at VI-8.

[21]Abrahms, *Mid-Atlantic Paging Stretches Network From Virginia to Boston*, WASHINGTON BUS. J., Sept. 17, 1990, § 1, at 23; Richards, *Pager Companies Count on Masses to Answer Call of Cheaper Fees*, USA TODAY, Sept. 5, 1990, at 6B; ROBINSON-HUMPHREY CO., REPORT ON MTEL (July 30, 1990); *MTEL Units in Service Exceed 125,000 at Year End; 78 Percent Increase Over 1989 Level*, PR NEWSWIRE, Jan. 10, 1991.

[22]Titch, *Nationwide Paging Companies Undaunted by Metrocast Folding*, TELEPHONY, July 16, 1990, at 8.

[23]*Ibid.*; ROBINSON-HUMPHREY CO., REPORT ON MTEL (July 30, 1990).

build an international paging network. By mid-1990, SkyTel's customers could be reached in over 100 U.S. cities and in Puerto Rico, the Virgin Islands, and Singapore.[24]

Table 1.2. Wide-area One-way Paging Services Market: Subscriber and Revenue Forecasts

Year	Subscribers (000)	Revenues ($ million)	Revenue Growth Rate (%)
1985	738.0	285.3	–
1986	957.2	381.2	33.6
1987	1,224.3	501.2	31.5
1988	1,530.4	642.8	28.3
1989	1,875.7	806.7	25.5
1990	2,215.4	976.6	21.1
1991	2,600.3	1,177.2	20.5
1992	3,023.2	1,407.0	19.5
1993	3,482.0	1,665.9	18.4
1994	3,969.2	1,952.2	17.2
1995	4,477.9	2,264.1	16.0

Source: MIRC, MOBILE COMMUNICATIONS SERVICES, at VI-21 (1990). The wide-area paging market makes up from 16% (in 1985) to 28% (projected 1995) of the total number of subscribers in the one-way paging market, and from 25% to 40% of total one-way paging revenues. *See id.* at VI-8 to VI-9.

In July 1982, MCI formed a partnership with the American Express Co., Metromedia Inc., and Communications Industries, Inc. to apply for one of the national paging licenses.[25] The partnership planned to use MCI's long distance telephone network of over 200 metropolitan areas to achieve a nationwide reach.[26] The partnership was unsuccessful in its license application, and in 1986 MCI sold its paging and

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[24]Titch, *Nationwide Paging Companies Undaunted by Metrocast Folding*, TELEPHONY, July 16, 1990, at 8.

[25]*Four Firms Announce Venture for Nationwide Paging System*, ASSOCIATED PRESS, July 28, 1982.

[26]*Ibid.*

cellular businesses to McCaw.[27] John Houser, an MCI spokesman, explained that MCI wanted out of the paging business because "it's cutthroat and difficult to make a profit." He observed that as many as 50 different companies might sell paging services in a given market.[28]

While telcos have been and remain important players in the paging market, they are by no means dominant. In 1968, 11 of the top 40 cities were served by telcos, while 36 of the top 40 were served by other paging companies. Of the 170 stations licensed nationwide, 25 were operated by Bell company affiliates, 9 by affiliates of independent telcos, and 136 by unaffiliated companies.[29] Today, the largest provider of paging services is not affiliated with a telco, and the industry as a whole remains highly fragmented. **TABLE 1.3**. According to a report by Telocator in 1989, "[r]adio common carriers collectively serve[] about 60 percent of the paging market. Private systems (e.g., hospitals, hotels) serve[] another 15 percent; telephone companies only 25 percent of the business."[30] Some RHCs have bought up independents -- in September 1990, for example, US West purchased Answer Iowa;[31] more recently, BellSouth has acquired the paging interests of Graphic Scanning Corp. and CellTelCo.[32] But in late 1990, NYNEX took the opposite tack and sold its entire paging business to an independent company, Page America.[33]

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[27] *Buyouts Shuffle 1985 Media Rankings, Part 1,* ADVERTISING AGE, June 30, 1986, at S-4. McCaw is the fifth largest paging company in the country with over 300,000 subscribers. *RCR Top-20 Radio Common Carriers,* RCR PUBLICATIONS, INC., Oct. 21, 1991. It has paging coverage in most of its cellular phone markets, as well as national paging services and voice messaging. *See, e.g.*, McCaw Sales Brochure & Coverage Map for Visalia, CA (current as of Feb. 1991) (brochure entitled *For Companies on the Move*).

[28] Tucker, *MCI Sells Cellular Radio Units*, WASHINGTON POST, Aug. 13, 1985, at E1. More recently, MCI announced its sale of two non-wireline RSAs (acquired through its 1990 purchase of Telecom USA) to Sterling Cellular. *Acquisition Spotlight: ALLTEL Scores in Missouri,* CELLULAR INVESTOR, Mar. 25, 1991, at 8.

[29] 14 F.C.C.2d at 271.

[30] Bean, *Paging Outlook 1995*, TELOCATOR, Jan. 1989, at 20. Today, telephone companies have just under 30 percent of the paging business.

[31] Richards, *Pager Companies Count on Masses to Answer Call of Cheaper Fees*, USA TODAY, Sept. 5, 1990, at 6B.

[32] *BellSouth, Graphic Scanning Complete Merger,* PR NEWSWIRE, Sept. 17, 1991; *BellSouth, McCaw Complete Cellular Transaction,* PR NEWSWIRE, Sept. 23, 1991; *Subsidiary Buys Paging License, Assets of CellTelCo,* WALL ST. J., Apr. 3, 1991, at C6, col. 4; *BellSouth Enterprises Buys Graphic Scanning Corp.,* MOBILE PHONE NEWS, Jan. 17, 1991, at 6.

[33] Feldman, *Beeper Company Sends Stronger Signal*, CRAIN'S N.Y. BUS., Aug. 6, 1990, at 3. In a recent rulemaking, the Commission altered these rules somewhat, holding that no person may "have a direct or indirect ownership interest in licenses for both frequency blocks in overlapping CGSa unless such interests pose no substantial threat to competition." First Report and Order and Memorandum Opinion and Order on Reconsideration, CC Dkt. Nos. 90-6 and 85-388, at 44 (Oct. 18, 1991). The Commission noted that a

Table 1.3. Market Share of Paging Subscribers.[34]	
Company	Market Share[35]
Paging Network	12.0
BellSouth	9.4
Southwestern Bell	9.1
Pacific Paging	5.5
McCaw	3.3
American Paging	2.4
Ameritech Mobile Communications	2.3
Page America	2.2
USA Mobile Communications	2.1
Metrocall	2.0
US WEST Paging	2.0
RAM Communications	1.8
Dialpage	1.8
Pronet	1.1
MTel/SkyTel	.9
Others	42.0
Total Subscribers	10.0 M

Cellular Telephony

The single-cell transmitters that provided mobile telephony until the 1980s could typically support a total of 25 channels.[36] Because of interference between channels, only about half of those could be used at a time. Since thirty subscribers might be

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controlling interest in both licenses would be anticompetitive and therefore forbidden, but stated that "for less than controlling interests or interests less than 50% in both frequency blocks an analysis will have to be made on a case by case basis in accordance with traditional antitrust principles." Ibid.

[34]Subscriber figures are primarily based on data from *RCR Top-20 Radio Common Carriers*, RCR PUBLICATIONS, INC., Oct. 21, 1991 and the following sources: *BellSouth, Graphic Scanning Complete Merger*, PR NEWSWIRE, Sept. 17, 1991; *BellSouth Enterprises' Mobilecomm Closes Nationwide Paging Deal with CellTelCo*, PR NEWSWIRE, Apr. 2, 1991; *Bell South Reports Third Quarter Results*, PR NEWSWIRE, Oct. 17, 1991; *Paging Leadership Presents Survey Results*, PR NEWSWIRE, Aug. 8, 1991; *American Paging Gold Pages Everywhere in Florida*, PR NEWSWIRE, Oct. 4, 1991; *Pronet Announces Third Quarter and Nine Months Results*, BUSINESS WIRE, Oct. 24, 1991; *Paging Industry Breaks 10 Million Subscriber Mark*, PR NEWSWIRE, May 12, 1991; *Millicom Appoints New President/CEO for its U.S. Alphanumeric Paging Subsidiary*, BUSINESS WIRE, Aug. 21, 1991; *Pronet Inc. Announces Second Quarter and Six Month Results*, BUSINESS WIRE, July 25, 1991; *U.S. WEST Paging Names Clint Scott Chief Operating Officer*, PR NEWSWIRE, July 12, 1991; *US WEST Announces Second Quarter Earnings*, BUSINESS WIRE, July 19, 1991; *BellSouth Announces Second Quarter Earnings*, PR NEWSWIRE, July 18, 1991; *Telephone and Data Systems Reports First-Quarter 1991 Results*, PR NEWSWIRE, May 6, 1991; *MTel Reports First Quarter Results*, PR NEWSWIRE, May 1, 1991

[35]Total percentage is less than 100 percent due to rounding.

[36]*AT&T Consumer Products Supplies Buick with Mobile*, PR NEWSWIRE, Sept. 13, 1983.

TELOCATOR

EXHIBIT 1
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ATTACHMENT B

The Personal Communications Industry Association

AN OVERVIEW OF THE RADIOPAGING INDUSTRY

A SPECIAL TELOCATOR REPORT

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October, 1991

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as it has the capability to provide information through the paging device itself, rather than merely prompting a phone call. Unfortunately, this advancement is also a step beyond the marketplace. Consumers who view paging as a simple alert service have no frame of reference to gauge the benefits of alphanumeric. Many carriers have also suffered from this lack of knowledge, and have been unsuccessful in marketing the service.

The lack of a consumer knowledge base on which to offer alphanumeric service also makes the service extremely sensitive to price. The cost of alphanumeric is much higher than that of other paging services. According to the 1990 EMCI/Telocator report on the paging industry, the average monthly cost for alphanumeric service on a rental pager was $32.90, compared to a cost of $14.41 per month for tone-only, and $22.57 for digital display. Given the lower costs of "traditional" paging services, it is understandable that consumers are not willing to pay a higher price for a service which they do not fully understand.

The technological advancement of alphanumeric also poses a problem with the means of inputing the message. Persons who wish to call a digital display pager can simply use a touch tone telephone to input their numeric message. With the addition of alphabetic characters, the means of input becomes a much more complicated issue. Touch-tone telephone input is possible, but the layout of three letters per number makes input quite complicated, and eliminates the use of the characters "Q" and "Z," which are not included on the touch tone keypad. For carriers offering alpha service, one common means of message input is the use of Telephone Answering Services (TAS). TAS operators record the message given by the caller, and type it into a paging terminal to be sent out. The overhead costs of this service to a carrier are substantial, especially in light of the low market share of alphanumeric paging. Another common practice is to provide keyboard terminals to customers with a large number of alpha pagers. This allows the subscriber to input the message directly. Again however, the overhead costs of doing this make many smaller carriers reluctant to offer alpha service, thus bringing down the market share.

Despite its low market share, the outlook for alphanumeric is quite good. Many carriers are recognizing that the industry is becoming increasingly information oriented, and are beginning to realize that alphanumeric is well positioned to take advantage of this trend. Companies are arising which offer value added data services which cater to the alphanumeric market. These companies provide stock market tracking, sports scores, and weather information. The numbers of these sorts of companies will continue to increase as more and more applications are found for alphanumeric data services. These value-added service companies, as well as carriers of alpha service, have begun to undertake the process of educating the market as to the benefits of alphanumeric. When the knowledge base in the market is raised to the level of the technology, the demand for the service is likely to increase, thus making the price differential between alphanumeric and other paging services less problematical.

As for the difficulties with message input, further advances in technology are making this issue less problematic as well. Activity on two technical fronts looks especially promising. Software has been developed that allows alphanumeric pages to be sent from a personal computer. These software applications are being offered by multiple vendors, and are quite reasonably priced. The proliferation of the PC in the workplace, in conjunction with the implementation of such software, seems to present an optimal environment for the growth of the alphanumeric service. A more longterm approach is the work that is being done on voice recognition technology. A number of companies are working on products which will allow voice messages to be translated into alphanumeric messages.

Despite the paging industry's increasing orientation towards information services, there will continue to be a market for each of the services which are offered. Services which alert subscribers to waiting messages will continue to fulfill many people's needs, while those persons who require information services will turn to alphanumeric and digital. Given the potential of recording capabilities, tone-voice will remain an option, especially for smaller carriers who do

not face the types of capacity restraints which face their larger counterparts. In any case, the variety of services offered by the paging industry makes it an attractive option for individuals who need mobile communication access.

II. Radio Technology and System Operation

Radio paging is a form of wireless communication which transmits signals through its use of the electromagnetic spectrum. In order to understand the paging industry, it is best to first have a basic understanding of the radio technology it is based upon, and the way this technology is implemented in a paging system. This section is designed to provide a technical context for the industry for those individuals with little or no background in radio technology. It is not meant to be a comprehensive review of all the technical issues involved in setting up a paging system: such is the work of an engineer.

Radio Wave Properties

Any discussion of paging technology must begin first with a brief discussion of the electromagnetic spectrum. The spectrum is made up of oscillating electrical and magnetic fields which may be visualized as sine waves. All broadcast media, microwave energy, visible, infrared, and ultraviolet light, and cosmic rays are forms of the electromagnetic spectrum. All waves have the same general characteristics, i.e. amplitude, wavelength, phase, and frequency. The distinguishing characteristic of electromagnetic waves is their frequency. The frequency of a wave is a measure of the number of crests that occur in one second. This is measured in a unit called Hertz, which refers to the number of cycles (crest to crest events) in one second. Differing frequencies result in different manifestations and utilizations for a wave.

Paging services make use of that range of the spectrum made up of radio waves, as do all other broadcast technologies. Within the range of radio frequencies, the Federal Communications Commission allocates specific frequency levels for particular services. For example, the number on the dial for a particular radio station (i.e. 97.5, 101.1, etc.) is actually the frequency of the signal that is being broadcast. Thus, FM radio stations in the U.S. are required to use frequencies between 88 and 108 megahertz (MHz). In the same way, all

services using the spectrum are given specific frequency allocations. This concept of exclusive frequency use is important, because conflicting signals which are sent at the same frequency result in interference which renders both signals indecipherable to the receiver.

Just as different services are granted specific frequency allocations in the radio spectrum, so too are different users granted separate frequencies within a given service. No two paging companies in a given market can operate on the same frequency, unless there is a predetermined sharing arrangement. This means that the use of a frequency by one service or company eliminates the possibility for the unfettered use of the same spectrum by another user. However, there is an important geographic limitation to this statement, made possible by the effect of distance upon a radio wave. The amplitude (strength) of a wave has an inverse relationship with its distance from the source. Simply put, a radio signal becomes weaker and more spread out as it gets farther and farther from its source. In a vacuum, in free space, the signal strength diminishes as the inverse of the square of the distance - commonly known as the inverse square rule. In free space, if the signal is 100 watts at 1 mile, it will be 25 watts at 2 miles (1/4 the power), 4 watts at 5 miles (1/25 the power) and so on. Since this is an idealized environment, the real-world diminution in power is even greater. The practical consequence of this power loss for radio towers is the radio horizon - the boundary of a transmitter's coverage area. Beyond the radio horizon, the signal strength falls very rapidly, allowing for the reuse of the same frequency by other users without the threat of interference. Therefore, two companies can provide paging services on the same frequency, so long as they are sufficiently distanced so as to avoid interference.

In order for a paging system to be successful, it is essential that the signal which is sent be able to reach the receiver (the pager) with a high degree of probability. If there were no impediments to the signal's propagation, this would not be an issue. Unfortunately, at least from an engineer's perspective, these impediments do exist, in the form of hills, buildings, and any other solid object. The degree to which these obstructions block or absorb the transmitted

signal is known as attenuation. At very low frequencies, radio waves bend (diffract) very well around large objects, making attenuation less of a problem. In the frequencies used for paging, diffraction does not occur easily. This causes shadowing on the unilluminated side of any obstruction. However, radio waves do reflect quite well off of hard surfaces, and several reflected waves can join together to form a signal. This is known as multipath propagation. Through the use of several transmitters, placed throughout the service area, shadowed areas are filled in by reflected rays. Although the reflected rays usually add together to amplify the original signal, they sometimes subtract from one another to make the signal drastically weaker. This phenomenon, Rayleigh fading, creates an environment in which the strength of the received signal can vary wildly over quite short distances. This is overcome by increasing the power output at the transmitters to a level high enough to withstand the drastic drops on signal strength caused by Rayleigh fading. System designers are successful in making paging reception almost certain, although never 100%.

Paging System Components

At a very basic level, the process of sending a message through the paging system is quite simple. The control center takes the phone number which was dialed and matches it to a pager's specific address, called a "cap code." Each pager has an unique cap code which allows it to receive those messages which are intended for its reception. In services other than tone-only, a message (i.e. phone number, text message) is received by the control center as well. When the message is input, it is manipulated into a format which allows for efficient transmission and is stored with its cap code. After numerous messages have been received, they are batched together and sent over the control link to all of the transmitters in the coverage area. The transmitters receive the message and rebroadcast it on the specified frequency. If the paging customer is within the coverage area of the system, the pager will receive the broadcast message. The fact that each pager has an individual cap code allows it to receive

only those messages which are intended for it, and to ignore any other broadcast traffic.

There are two means by which the message may be input to the control center. In some smaller systems, and in many alphanumeric systems, all paging requests go through a manual input system, where a telephone operator takes the message and enters it into an encoder to be sent over the paging system. Much more common is automatic input, where the paging provider negotiates an interconnection agreement with the local phone company. By the terms of this agreement, the paging company is given a block of phone numbers to be assigned to its pagers. At the control center, a piece of equipment called a terminal receives the call and, in services other than tone-only, prompts the caller for the message that is to be sent to the subscriber. Thus, the message is input through the Public Switched Telephone Network, and does not require a human operator to answer the call or enter the message.

In an automatic input system, the terminal is by far the most crucial piece of equipment. It is essentially a computer with specialized software which allows it to perform the following functions:

1) Match the number dialed to a specific cap code;

2) Determine which frequency the message must be transmitted on;

3) Manipulate the message into a format for transmission;

4) Perform billing and accounting.

The third function listed above is known as encoding. Through this process the message that has been input is translated into another format which allows it to be transmitted more efficiently. Encoding can be either in analog or digital form. An analog signal varies continuously, and can take on any value between zero and some maximum. An example of an analog "signal" is the human voice. It is continuous, and varies in pitch and strength. Digital signals, in contrast, are composed solely of pulses which may take on only certain fixed values: either zero (on) or one (off). This is expressed as a series of binary digits, known as bits. Thus, a digital signal is actually a stream of bits, zeros and ones, which are transmitted at a

certain rate of bits per second (bps). In the paging industry, and in most other communications systems, digital encoding is the most common technique. One reason for this is that digital signals are well suited for transmitting numeric and alphanumeric messages. In this situation, each letter, number, and character which could be transmitted is assigned a binary equivalent. Another important advantage of digital is its increased capacity. Since the only two options for a pulse in a digital signal are zero and one, less information needs to be transmitted. This allows for increased capacity and more efficient use of radio spectrum.

The function of the terminal is to translate the message that is to be sent into a digital format, and to structure the digital translation so that the receiving pager can decipher it. This structuring is accomplished through the use of a specific encoding format which is known both by the terminal and by the pager. The two most commonly used of this formats are Golay, which is a proprietary code by Motorola, and POCSAG, also known as CCIR #1. POCSAG was accepted by the CCIR (an international standards organization) as the industry standard encoding format, and was placed in the public domain. This was of great assistance to manufactures of paging equipment, who were able to design around a format without fear of patent or copyright infringement. For this reason, it is the most common encoding format. Although Motorola has not abandoned its Golay format, due to its huge market share in the manufacturing of pagers, it also manufactures pagers in the POCSAG format. While the precise specifications of these formats is beyond the scope of this report, it will suffice to say that each provide a means of structuring the bit stream of the paging transmission so that it can be understood by the receiving unit.

After being encoded and formatted by the terminal in the control center, the message that is to be sent is then passed along over the control link, which allows the message to be received and rebroadcast by all of the transmitters in the service area. This control link may take the form of wireline connections between the control center and all of the transmitters, or more commonly, may be a dedicated radio frequency which is separate from the frequency